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VII.—*The North-American Boundary from the Lake of the Woods to the Rocky Mountains.* By CAPTAIN S. ANDERSON, R.E., Chief Astronomer, North-American Boundary Commission.

[Read, March 27th, 1876.]

THE international boundary-line between the British possessions in North America and the United States, in the central part of the Continent from the Lake of the Woods to the Rocky Mountains, was established by treaty in 1818 ; but more than half a century elapsed before the necessity arose for surveying and marking the boundary-line on the ground. The Red River Valley was long ago known to be partly in British and partly in United States territory ; but in the early stages of the history of the Red River Colony, all its settlers had come from the British side, and no international question arose. The French fur-traders penetrating from Lake Superior to the westward, across a most difficult country of lakes, and swamps, and rocky ridges, had come upon the Red River Valley early in the eighteenth century, and must have realised its great capabilities for settlement. The Hudson's Bay Company, advancing southwards from their headquarters at York Factory on Hudson's Bay, by an equally difficult route, had in the early part of this century also reached the prairie-lands of Red River. The sole object of these rival Companies was the fur-trade, and they had no interest or desire to open up the country for agricultural settlement, or to press for a settlement of the question as to the precise position of the boundary-line. Lord Selkirk, a prominent partner of the Hudson's Bay Company, on his own account, made a treaty with the Indians, purchased some of their land, and in 1812 established on it a colony of Sutherland Highlanders, whom he imported by way of Hudson's Bay, and he left them on the banks of the Red River to endure great hardships, which were aggravated by the constant hostilities of the rival Fur Companies, who, after carrying on a war of extermination with each other for some years, eventually made peace in 1821, and joined in partnership. This union caused the canoe-route to Lake Superior practically to be abandoned for trade in favour of the more northerly route direct to the seaboard. The latter route was available during the months of June and July only, and the ship that annually came from England with supplies took away the furs. The Red River colonists were, therefore, almost cut off from communication with the outside world ; while it was impossible for new settlers to come into the country unless they were imported by the Hudson's Bay Company.

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In course of time some adventurous traders of the Red River Colony explored southwards, following the course of the Red River to its source, and then crossing the plateau of swamps from which the tributaries of the Mississippi and Red River take their rise, came upon the head-waters of the Minnay Sotor, and thus prepared the way for developing the natural outlet for the commerce of Red River to St. Paul, at the head of the navigation on the Mississippi, and to the then projected terminus of the railroad system of the United States. The railroad was soon extended northwards across the marshy plateau to the head-waters of Red River; and with these facilities, the emigrants coming to Minnesota, and finding the country to the westward a wild, dreary waste unfavourable for settlement, pushed forward down the Red River Valley and established themselves on the river-bank towards the frontier. Subsequently, in 1869, on the creation of the Dominion of Canada, the territory rights of the Hudson's Bay Company were sold to the new Dominion, and after the peaceful settlement of the rebellion in Red River, by the expedition under Sir Garnet Wolseley, the Colony was made a Province of the new Dominion, and a route, available during the summer only, was opened out at enormous cost through British territory, following generally the old canoe-route of the French fur-traders, by which emigrants were encouraged by the Government to settle in the new Province. Thus new settlers came in from the south, and to some extent from the east by the new route, and established themselves in the valley in the neighbourhood of the boundary-line. Near this supposed locality, some twenty years ago, the Hudson's Bay Company had established a trading-post, where the Chippeway Indians, living and hunting near the lakes to the south and east, traded their furs. It was contended by the United States authorities that the Hudson's Bay Company's trading-post was on the American side of the line, and this contested point remained in abeyance till the British and United States Governments agreed to appoint a Joint Commission to settle the matter, and at the same time to complete the demarcation of the boundary-line across the continent, from the point at the north-west corner of the Lake of the Woods, established in 1825 (the westernmost point agreed to between the two Governments under the 7th Article of the Treaty of Ghent), to the summit of the Rocky Mountains, the westernmost point agreed to and established fourteen years ago under the Oregon Treaty of the 15th of June, 1846. The interval of boundary thus remaining undefined comprised about 900 miles of frontier line in the central portion of the Continent, and, in the words of the treaty, this portion of the boundary was to be "A line

drawn from the most north-western point of the Lake of the Woods, along the 49th parallel of north latitude; or, if the said point should not be on the 49th parallel of north latitude, then, that a line drawn from the said point, north or south as the case may be, until the said line shall intersect the said parallel of north latitude, and from the point of such intersection due west, along and with the said parallel, shall be the line of demarcation between the territories of Her Britannic Majesty and those of the United States from the Lake of the Woods to the Rocky Mountains."

In the month of June, 1872, the British Commission was appointed, consisting of Major Cameron, R.A., Commissioner; Captain Anderson, R.E., Chief Astronomer; Captain Featherstonhaugh and Lieutenant Galwey, of the Royal Engineers, Assistant Astronomers; Captain Ward, R.E., Secretary. Lieutenant Rowe, R.E., was subsequently appointed to the Commission as Surveying Officer. Forty-four of the Royal Engineers were specially selected and detailed for duty with the Expedition; and a contingent of surveyors and assistants was appointed by the Dominion of Canada, as well as Dr. Burgess, Surgeon; Mr. Boswell, Veterinary Surgeon; and Mr. G. M. Dawson, Geologist. As soon as the Commission was appointed, the Commissioner and Secretary started at once for Canada, where all ordinary stores and provisions were purchased and forwarded to Red River. In order to ascertain and mark this international boundary with the greatest possible accuracy, it was considered necessary to provide the best class of portable instruments that could be constructed; and with the advice of the Astronomer Royal, under whom the officers were instructed in the special duties required of them, the specification for such instruments as were best adapted for the work was prepared, and the whole order was entrusted to Messrs. Troughton and Simms, who with the greatest skill and energy applied the whole of their staff to the execution of the order. As soon as the equipment and outfit were complete, the officers and detachment of the Royal Engineers left Liverpool on the 22nd of August, 1872, with the special stores and instruments required for the Expedition.

Proceeding via Quebec and the Canadian Lakes, the party travelled by permission of the United States authorities from Duluth, on the western shore of Lake Superior, through the State of Minnesota by rail, to the head-waters of Red River; thence, partly by marching and partly by river-transport, reached the frontier at Pembina on the 20th of September. Here the contingent of Canadian officers and *employés* reported for duty, and here the Commission appointed by the United States were also assembled in readiness to commence jointly astronomical

and surveying operations. The season was already well advanced, and the first experience of the Joint Commission in camp on the Red River Prairie was a violent snowstorm, from the north-west, which raged with great violence for three days, and greatly delayed field-operations. The settlers foretold that this was the harbinger of fine autumn weather, which proved to be the case; for during the succeeding month bright and genial weather prevailed with a sultry, hazy, and motionless state of the atmosphere, popularly known throughout Canada as the Indian summer. The position of the boundary-line at Red River was carefully determined independently by astronomical observations taken by the two Commissions, and the results differed by 32 feet, or about one-third of a second of latitude.\* This difference was halved, and the position of the boundary-line, as then agreed to confirmed the rough observations that had been previously taken by Captain Palliser and others. The principal point now settled was, that the Hudson's Bay Company's trading-post, the territorial position of which had been disputed, was ascertained to be 250 yards within British territory. In order to take advantage of the open weather that might be expected during the month of October, three astronomical parties were organised by the British Commission, and two of them proceeded to the Lake of the Woods, to commence operations there in concert with the United States Commission; and the third party commenced work at an intermediate point on the boundary between Red River and the Lake of the Woods.

A difficulty presented itself at the outset, as to the exact position of the north-west point of the Lake of the Woods, determined by a former Joint Commission in 1826, being the terminal point of the operations under that Commission, and the initial point of the work of the present Commission. The point was described as being in a swamp, and there being no firm ground in the neighbourhood a pyramid of logs was constructed about a mile south of the spot, at an exact specified distance from the point, which the Commissioners in 1826 had agreed upon as the north-west corner of the Lake of the Woods. All traces of this wooden pyramid had disappeared, but the traditions of its construction were fresh in the memory of the Indians, and guided by the directions of an old man of the Chippewa tribe, some younger members of the tribe indicated a spot, then 18 inches under water in the swamp of the district, from which spot an oaken log was dug up, and the impression

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\* The method of working and marking the boundary-line is explained in the Appendix.

of a frame in the marsh was noticed, such as would have been made by a pyramid of logs. We were further aided in our investigation by some additional particulars communicated by Mr. Barclay, the British Commissioner of 1826, who, I am happy to say, is still alive; and, though at an advanced age of nearly 90 years, retained wonderful recollection of the circumstances connected with the questions now referred to him. An independent investigation from our own observations and measurements indicated the restored site of the old pyramid only 400 feet distant from the Indians' site. This extraordinary coincidence left no reasonable doubt that we had found the old site, and the Indians' spot was accordingly adopted, and served as the starting-point of the operations of the new Commission. The north-west corner of the Lake of the Woods was re-established and found to occur in a grassy marsh covered by 3 to 4 feet of water. The international boundary-line, starting from the north-west point of the Lake, follows by the terms of the treaty a due-south line for 26 miles to its intersection with the 49th parallel in the open water of the lake.

For the first 16 miles the line cuts off a promontory of the western shore of the Bay, passing over a continuous swamp more or less wooded. In the northerly portion of the line the timber is dense, consisting of birch and tamarac a species of larch, and a great entanglement of fallen timber covers a treacherous swamp, having in bare places a mossy surface which gives way under foot, and underneath is mire and water of varying depth. The cutting and surveying of this line was attended with considerable hardship and difficulty, camp equipage and provisions being transported on men's backs, and for this service, as well as for clearing the line, Indians were employed. The natives of the Lake of the Woods are most independent, and little inclined or physically able for continuous hard work. It became necessary to humour them a little to prevent them abandoning a work which necessitated their being knee-deep in mud all day. The great talker of the party, who is well known throughout the country, began by a great flourish, and very soon disabled himself with his own axe, and eventually settled down as the cook of the party. He was famous for the extraordinary load of miscellaneous baggage that he could collect into one bundle and carry on his back, with the portage straps across his forehead, and jump from log to log, when shifting camp down the cutting. The Indians would only work on the condition that I would take care of their wives and families during their absence. Twelve or fourteen families accordingly arrived and set up their lodges close to the Observatory Camp, and an occasional issue to them of a little flour and bacon

was equally divided among their number, and used with surprising economy. After living almost entirely on moose-meat and a few roots, they have an indescribable craving for flour. During the progress of the work the frost set in on the 8th of November, and travelling through the swamps became easier, though an early fall of snow prevented the swamps from freezing, and the ground continued to be treacherous till the snow along the travelled trail had become well consolidated by constant foot traffic. The due-south line passes almost invisibly from swamp into the open lake, the timber, becoming more and more stunted, merging into willow-bushes and coarse reedy grass. The actual lake-shore was indicated by a sandy beach, on which a few willows struggled for existence; and the surf which had beaten violently on the beach during the prevalence of southerly winds had now become frozen into most fantastic forms, and the floating ice which had been drifted to land was packed and consolidated in a rugged and confused mass, which extended for some distance into the lake, and was merged at last into the regular icy covering which now held the surface of the lake fast. Inland from the beach, a belt of open marsh, fully a mile in width, had become coated with glare ice, 2 feet in thickness, and this ice, which had formed under more peaceful conditions than that in the open lake, was as clear as crystal and strangely beautiful. In striking contrast with the icy desolation of the scene, the Indians, on finding that their work was at an end, ran forward with wild joy, shouting, and enjoying the frequent falls that they met with in rushing thoughtlessly over the ice, till they arrived at the beach-line, where an imposing flagstaff was set up. Just at this time a snowstorm, which had been threatening from the southward, came up with great fury, and, with a temperature below zero, everyone was compelled to cover his face; and the retreat to the sheltered cutting in the woods was almost cut off by the severity of the storm. The true direction in which the men had to travel was only ensured by ranging the men in line, and prolonging the line of travel by looking back on those in rear, who were not allowed to move forward till the foremost ones were placed in line.

The boundary-line continues southerly for 10 miles across the open lake, and intersects the 49th parallel at a spot in the lake where the soundings showed 30 feet of water. Proceeding then due west for 6 miles, the boundary-line intersects the western shore of the lake, at which point a series of observations was taken by the Joint Commission on a little sandy ridge, where a few poplars were found, and a dry spot for the encampment. Close by, a small and independent band of Indians was established, who cultivated some small

patches of land, and owned a few cows, the only remaining evidences of the civilising influence of the early French traders who settled at the Lake of the Woods a century before the conquest, and of whom some faint traditions were told to Sir Alexander McKenzie, on his first visit to the Lake of the Woods, in 1789. The thriving trade which appears to have existed at the Lake of the Woods in furs and fisheries, in the time of the French traders, 200 years ago, has now almost ceased, partly on account of the supply having been reduced, and partly by the diminution by war and smallpox in the number of Indians now residing on the lake-shore. Sir A. McKenzie alludes, in 1789, to the Lake of the Woods as being remarkable in consequence of the Americans having named it as the spot from which a line of boundary between them and British America was to run west until it struck the Mississippi, which, however, he says, never can happen, as proved by Mr. Thompson, Astronomer to the North-West Company, who was sent expressly in 1798 to examine the ground, and reported that the northernmost waters of the Mississippi and one of its tributaries, the Missouri, lie altogether south of a line drawn due west from the north-west corner of the Lake of the Woods. Although this gentleman reported that the north-west corner of the Lake of the Woods was in lat.  $49^{\circ} 35'$ , and the northernmost bend of the Missouri in  $47^{\circ} 32'$  the actual boundary-line was directed by the Commissioners on the 20th of October, 1818, to follow a meridian line *due north or due south* from the north-west corner of the lake to the 49th parallel (although a due-south course was indicated by Mr. Thompson's observations), thence westward along that parallel to the Rocky Mountains; and the same line of latitude ( $49^{\circ}$ ) was adopted that the Hudson's Bay Company had suggested in 1714 to the French Government as the boundary-line between the territories of the British and French traders, who it was expected might come into collision with each other, when pushing forward their trade into the interior of the Continent.

The initial point of the 49th parallel at the Lake of the Woods' western shore was marked on the ground by the Joint Commission of British and United States officers in November, 1872, where after an elaborate series of observations by both Commissions, the independent results when staked out on the ground showed an overlap of territory of 29 feet, and this was most amicably halved, and the intermediate point agreed to as the initial point on land of the boundary-line. The further survey and marking of the line westerly, over 90 miles of country intervening between the Lake of the Woods and the Red River, was accomplished during the winter of 1872-73, by astronomical

parties working from both sides. This region had hitherto been a *terra incognita*, unexplored by white men; and described by the Indians as a vast and treacherous swamp, the freezing of which was retarded by the overlying snow. These swamps were found to be quite impassable for wheeled vehicles or pack-horses during the open season; but by making a *detour* from Red River towards the south for 25 miles, access was obtained to a point on the boundary, 57 miles west of Red River. From this point progress in either an east or west direction was impeded by swamp, and the work was continued with much difficulty till winter set in and the surface of the swamps gradually froze. As the winter advanced and the snow increased in depth, the working parties were supplied with leather clothing and extra buffalo-robies, and the men acquired readily the use of snow-shoes, while the transport of stores and provisions to the most advanced parties was accomplished by dog-trains. Although it was generally supposed that as soon as winter set in, field operations would necessarily be suspended, it was found that the advent of the frost afforded the greatest assistance to the work, for both men and transport animals were spared the excessive fatigue of working through the unfrozen swamps. It was soon ascertained, too, that the winter was the only time in which the country between Red River and the Lake of the Woods could be surveyed, as the swamps were almost continuous, and only intersected at intervals by belts of timber. Although the cold was at times intense, the thermometer often showing 40° below zero, and on one occasion 51° below zero, the working parties were for the most part protected in camp by the woods, and as long as the air was still, no great discomfort was experienced. The least wind, however, caused much suffering and many frost-bites. In using the astronomical instruments, care had to be taken not to touch the metal of the instrument with the bare hand. The observer would occasionally find his eyelid frozen to the eye-piece of the instrument, as experienced by the Russian officers in Siberia. While on the march in a cold wind, the traveller would frequently find his eyelids for the moment frozen together. A severe snowstorm swept over the country on the 7th, 8th, and 9th of January, 1873, causing great loss of life in Minnesota, farmers with their families being caught when driving in sleighs, attempting journeys of a few miles from neighbouring houses. I have a vivid recollection of the storm, in consequence of being out in the open country at the time travelling on snow-shoes, in company with two attendants, and a dog-train carrying blankets and provisions. The dogs were stung so pitilessly in their eyes and ears by the drifting snow, that it was impossible to get them to face it; and they continually

rolled over and buried their heads in the snow. Shelter was at length found in a small island of poplars, and we kept body and soul together by huddling round a fire which was kept going for about eighteen hours, when want of food compelled us to continue our journey. The next day we reached an Indian camp, where we were most kindly received and cared for. The last part of the journey was across the open lake, and the direction of travel could only be kept by running in the teeth of the storm, which happened to be as good as a compass-course. Nothing could have made the dogs travel at the last, except their wonderful sagacity in discovering by scent that there was an Indian camp in front of them, although they had still some miles to go before reaching it. Not the least distressing trouble was having one's face stifled by a muffler, which soon became frozen solid to the face and beard by the moisture of breathing. It thus became necessary, after a few hours' travel, to halt and if possible to get into shelter, and make a fire and thaw out one's face, to prevent suffocation. This storm caught all the working parties of the British Commission at different points where they happened to be at the time, but fortunately caused no loss of life. Two of our men who were out at the time, driving a pair of horses in a sleigh and carrying supplies, were caught in the open prairie, and, being unable to proceed or go back, they lay in the bottom of the sleigh for two days and nights, and were at last rescued without having suffered permanent injury. Their horses, which had been let loose, found their way back to the point from which they had started, and thus gave the alarm which caused the despatch of relief to the sufferers. Although the prevailing weather during the winter months was cloudy and stormy, there were occasional days and nights of clear weather and motionless atmosphere; on these occasions the thermometer would show the greatest degree of cold, and in the woods one audible evidence of the intensity of the cold was occasioned by the freezing of the sap in the trunks and branches of the trees, and the consequent bursting of the bark with a report like pistol-shots. This chorus would continue through the night, and the frequency and violence of the reports would afford a good comparative measure of the cold. On these clear nights the auroras were most brilliant, vapour-like and yet perfectly transparent, so that even the small stars could be distinctly seen through the illuminated mist. One of the grandest that I witnessed formed a canopy in the zenith, and shot out on all sides towards the horizon radial flashes of light ever varying in length and breadth, now advancing, now retreating in a dissolving view, and lighting up the heavens with the glow of early dawn.

The result of the first winter's operations was the completion of the boundary work between the Lake of the Woods and Red River, the work having been continued uninterruptedly in the field from the day of our arrival in September till 3rd April, when the breaking up of the winter and the thawing of the swamps would have rendered operations in those districts impossible. The whole of this section of the work was completed, however, in good time, as well as a topographical survey of the country for 6 miles north of the boundary, by which the position of all important features such as rivers, lakes, and ridges was fixed with reference to the boundary-line. Early in April the whole of the British Commission was collected at Red River and comfortably housed in quarters which had been specially built for us during the winter. The quarters consisted of eighteen wooden buildings, capable of accommodating eleven officers, seventy-eight men, and one hundred and seventy-four horses or oxen. They were built by contract, and completed within two months of the date of commencing them. Although the season had been most trying to the transport-animals, principally on account of our being unable to transport sufficient quantities of hay for their sustenance, the officers and men enjoyed good health, and only a few cases of serious illness occurred.

During the winter of 1872, advantage was taken of a line of telegraph connecting the Red River Settlement with the United States to exchange telegraphic signals for the determination of the difference of longitude between our observatory camp at Red River and the United States observatory at Chicago. Nine hundred miles of wire were placed in continuous circuit, and instantaneous comparisons of the local time at the two ends were made on five successive nights, simultaneous with observations of the stars for determination of local time at each place. In midwinter the insulation of the wires was perfect, and this long circuit was worked without difficulty; though great trouble and annoyance was occasioned by the clerks at the numerous intermediate stations fighting on the wire, that is, trying to send simultaneous messages when only one message at a time was practicable, and they occasionally sent me abusive messages for occupying the wire with what appeared to them nonsense. The observations were fortunately completed before the great snow-storm, already alluded to, which swept down hundreds of miles of posts and wires, and destroyed telegraphic communication for two months as effectually as if it had been done by the scouts of an invading army. The correct position of the crossing of the boundary-line at Red River was now determined in absolute latitude and longitude, the former by duplicated observations of the Joint

Commission giving independent results differing by 32 feet only, as already stated ; and the longitude determined with a probable error of less than 100 yards with reference to the meridian of Chicago, which had previously been connected with Greenwich. This result will be of the greatest possible importance in the future, as it will be the starting-point of all surveys in the central portion of the continent where the accurate geographical position of important points had hitherto been so little known, that the old official maps showing the north-west point of the Lake of the Woods had an error of  $4\frac{1}{2}$  miles in longitude. This might have been expected from the means at the disposal of the surveyors when the survey was made fifty years ago.

On the breaking up of the winter, there was an interval of about six weeks in which no field operations could be undertaken, in consequence of the whole country being flooded by the rapid melting of the snow ; and vegetation made little or no progress till the middle of May, by which time night-frosts became less frequent. At that season one warm day and one warm night following were sufficient to make the whole surface of the prairie green with new vegetation springing into life, and at the same time mosquitoes began to swarm in myriads, and continued to increase in numbers and ferocity as the spring advanced. During the six weeks' cessation from active work much preparation was needed for the operations of the ensuing season, and in order to make the most of the short summer season of about five months, arrangements were made to distribute the working parties simultaneously over about 90 miles of boundary, and attack the work at several points at once. To do this advantageously, it became of the utmost importance that the country should be well explored and reconnoitred, in order that no delay should occur to the several parties proceeding at once to take up the work at convenient points. This work was accomplished by a reconnaissance party, consisting of thirty scouts selected from the Red River half-breeds. They were mounted on their own ponies, and armed with Spencer carbines. The scouts were lightly equipped, and were accompanied by an officer by whom the necessary astronomical observations were made for latitude and longitude, and by whom a reconnaissance map of the country was prepared showing all important features. The best route for travel was also marked out, the most suitable spots noted for halts and encampment, and dépôt sites selected for storing and distributing supplies. The approximate position of the boundary-line at points where more accurate observations were to be taken was also marked, so that the astronomical parties were able at once to proceed to their destination and set up

their fixed observatory instruments within one hundred yards of the boundary-line, and subsequently measure north or south to the exact position of the 49th parallel when the final result of the observations and calculations was known. The work of the reconnaissance party was thus important, as it greatly facilitated and expedited the subsequent operations.

Of the country to the westward of Red River little or nothing was known. The fine alluvial prairie of the Red River Valley was found to extend for 35 miles to the westward, and then to be bounded by the first Prairie Steppe called Pembina Mountain, an ancient shore-line which was conspicuous for many miles before reaching it from the eastward, as an unbroken blue ridge with elevated table-land beyond. This proved to be wooded with a small though dense growth of poplar, and the boundary-line passing through 8 miles of rough ground, came upon the gorge of the Pembina River, which flows in a deep ravine 350 feet below the table-land, and 3 miles in width from summit to summit. In this district during the month of June 1873 the locusts were being hatched in swarms, and in sunny situations, especially on the logs of fallen trees, they were most abundant. These insects were only in the crawling stage at that time, but later on they took flight and completely devastated the crops in the Red River Valley. In consequence of the ground being very much broken at the boundary-line in Pembina Mountain, the line of travel for heavy waggons was diverted 8 miles to the north, where the river was found to be fordable when the waters were at their ordinary summer-level. On passing this ravine an ascent is made to the upper plateau and to the commencement of the great plains which extend in one vast expanse, more or less broken, to the base of the Rocky Mountains, 700 miles distant. The great plains resemble a land sea, sometimes perfectly level, at other times abounding in hillocks and undulating ground, and occasional prominences rising 30 or 40 feet above the general level of the plain are met with, from which a panoramic view can be obtained to the horizon 10 or 12 miles distant. From these elevations the vastness and solitude of the plains can be seen and realised. A clayey soil, with some admixture of sand, supports a stunted growth of prairie-grass growing in bunches, and in every direction across the plain buffalo-tracks or old pathways are distinctly marked, and in many places the bleached skulls and bones of the buffalo are scattered about, in evidence of the vast numbers that must formerly have grazed over the ground, and of the wholesale slaughter that has practically exterminated them in this section of country. The only signs of life that attract the traveller's attention are the innu-

merable badger-holes by which the plain is honeycombed, and the soil is frequently found to be newly disturbed by these indefatigable animals, as if they were attempting to bar the progress of the rider by countless and treacherous pitfalls. In proceeding to the westward on the boundary-line, the first section of the Great Plains is found to be 70 miles in width ; over this area there is, in common with the whole tract of plain in the central part of the continent, no rainfall during the summer months except from passing thunderstorms, and the growth of the scant prairie-grass during the months of May and June is altogether dependent on the moisture derived from the melting of the winter snow ; the snow-water collecting in hollows forms pools which supply moisture for some weeks during the early summer to the adjoining soil. But for this circumstance the excessive heat of the sun during the month of June, and the want of rain would convert the prairie surface into a sterile waste. Patches of good grazing-ground can be found in all directions ; but, in consequence of the want of rain and the exposure of this area of plain to the cutting winds from the northwest, and the frequency of night-frosts during the summer over the country here elevated 2000 feet above the level of the sea, the soil is not suited for the growth of cereals, but there will always be good pasture, the value of which has been proved by the presence of the buffalo in former times. The short grass that comes to maturity in the moist hollows and undulations of the plain is most nutritious, and grazing animals would fatten on it rapidly, were it not for the incessant mosquito plague which drives even the domesticated animals almost wild, and keeps the strong ones poor, while the weaker ones fall away and die if they are put to any kind of work. During the heat of the day the mosquitoes become torpid, and there is a lull for a few hours, when the horses and oxen can graze and rest in peace.

After crossing the 70 miles of plain levelled by the great drift in former ages, which has left great boulders of granite and limestone stranded in all directions, a curious elevated and thickly wooded district occurs, extending for 34 miles along the boundary, and this feature, known as Turtle Mountain, from its shape as seen in the distance against the sky-line resembling in appearance the head and body of a turtle, commencing in United States territory, protrudes for 8 miles across the line into British territory, where the principal portion of the wood occurs in consequence of having a northern exposure. The wood is chiefly poplar, but oak and white birch with ash-leaved maple are also found, and some of the poplar-trees in sheltered places are 2 feet in diameter. The interior of the mountain abounds in lakes and swamps, so large and numerous that the Indians were of

opinion that we should fail in our attempt to survey and mark the boundary in a continuous line across the mountain. The difficulties pointed out by the Indians were not exaggerated; for it turned out that the boundary, in its course of 35 miles in Turtle Mountain, crossed sixty-five pieces of water, of which twenty-five are true lakes with gravelly shores, necessitating a survey by triangulation instead of the ordinary method by direct chaining. The marshes supported a permanent crop of wild vetches on which the horses fattened rapidly, and the water, though stagnant, was generally good. A party of British surveyors and axemen was occupied during the whole summer season of 1873 in tracing the boundary through the mountain for 24 miles from the eastward, when a junction was effected with a working party of the United States who had entered the mountain from the west, and marked the boundary-line eastward for 10 miles, when further progress from that side was barred at the time by a large lake more than a mile across, and extending for some miles into British and United States territory. The vivid greenness of the woods and the solitude of these well-sheltered lakes made many parts of the mountain singularly beautiful, and the melancholy cries of the loon, or northern diver, alone disturbed the peacefulness of the scene. Many red deer and bears are found in the mountain, and are hunted by a few families of the Sioux Indians, who, though belonging properly to the United States side, have taken refuge on the British side since 1861, when they declared war with the United States by massacring nearly all the American settlers in the upper portion of the Red River Valley. These Indians now carry on a good trade in furs, which are exchanged at the Fort Garry Settlement for ammunition, guns, or articles of clothing. This district of Turtle Mountain will be invaluable to settlers in the future, furnishing, as it does, an ample supply of wood for building and fuel purposes, and wintering ground for stock, while the adjacent plains will serve as grazing ground during the summer. During the operations of the Boundary Commission a dépôt was kept up here for storing supplies, and a large store-house constructed of poplar logs, in which the care-takers lived during the winter months. Communication with the headquarters at Red River was somewhat precarious at that season except by dog-trains, but the more northerly settlements on Red River are of easier access in consequence of intervening strips of timber, where travelling in winter would be less dangerous than crossing the 70 miles of open prairie immediately to the eastward. The effect of the wooded area of Turtle Mountain was very marked in attracting rainfall from the clouds, while the surrounding plain suffered from continued drought.

The thunderstorms, especially, seemed to discharge themselves here with terrible violence, and the lightning appeared in balls of fire flying into the ground, and in such quick succession of flashes that at night the air seemed to be continuously illuminated. On the hottest days there would be occasional nail-storms, with hail-stones as large as the eggs of a bantam fowl, causing at once a consternation and stampede among the horses. When encamped in the open plain, the hurricane that accompanies the thunderstorm frequently lays low every tent in the camp, while the plain for the time is converted into a vast lake. In the course of half-an-hour every symptom of the storm will have disappeared, and the mosquitoes will have renewed their attacks fiercer than before.

The great plains continue beyond Turtle Mountain for 138 miles, at an average elevation of 2000 feet above the sea; the only breaks that occur in the monotony of the scene are occasioned by the Souris River, which, in its meandering across the plain, has cut out a valley of varying width from 1 to 2 miles, and a depth of 150 feet below the plain. In the shelter thus afforded some timber grows on the bank of the stream, and there is an abundance of good pasture at all seasons. The operations of the Joint Commission in this portion of the work were greatly assisted by this valley, which crossed and recrossed the boundary several times, and always afforded good camping-ground. At one point in the Souris Valley, near the boundary-line, occur some remarkable rocks, known as *Les Roches Percées*, which have long been objects of superstition and veneration by the Indians. A soft sandstone, which underlies a capping of harder stone, has weathered into most curious figures, some castellated, and the whole series presents the appearance of ruined dwellings, which the Indans believe them to be. The soft rock bears in many places rude Indian carvings with birds and other animals.

No difficulty was experienced in tracing the boundary-line continuously across the Great Plains, but the constant mirage greatly delayed surveying operations during the day; for over the whole prairie surface the air was in continual agitation, and in looking through the telescope at a distant flagstaff it was seen to dance with persistent contortions, and no observations to terrestrial objects could be made from point to point with accuracy, except in the early morning or late in the evening. Unhappily, when the flagstaves were at rest the mosquitoes were most active, and altogether the observers had not an easy task. The general level of the plain is not disturbed for 140 miles west of Turtle Mountain, but a warning of some change in the character of the country was given by a low-lying ridge

bounding the distant horizon to the westward, forming a coast-line to the land-sea beneath it; and this feature, which becomes less and less defined as one approaches it, is the Great Coteau of the Missouri, and is one of the most important features of the western plains. It is the second prairie steppe of the North-American Continent, and crosses the country from north-west to south-east. This coteau or prairie steppe leads to a very remarkable plateau, of an average elevation of 2250 feet above the sea, which is broken up in a succession of ridges, valleys, and basins, presenting in section a very broken and irregular profile. The boundary-line for 50 miles crosses the Great Coteau district, and over the whole of this distance there is no well-defined ridge or water-course, but the same confused monotony of ridges and hollows. Those are succeeded, as one travels westerly, by a more undulating country, in which large alkaline lakes occur; and as the waters evaporate during the summer, a white saline deposit remains on the shore-line, which contrasts strikingly with the Salicornia, a crimson plant which fringes the salt lakes, and at once marks their brackish character. The chain of salt-lakes extends in almost an east and west direction for 15 miles, and over the whole of this district, including the Great Coteau, the waters have no outlet to the ocean. We are thus in the central water-parting of the continent; for the waters we have left behind us find their way by the Red River into the Hudson's Bay, while the ravines that are now opening out to view towards the west drain southwards to the Missouri, and find their way to the Gulf of Mexico. A great change is now observable in the topographical features; owing to the nature of the soil, which is of clay and very friable, denudation proceeds very rapidly during the short period that the soil is saturated with the snow-water, and the valleys are often scarped by deep and almost vertical sides, which in many places become baked by the heat of the sun and resemble retaining walls. The peaks and ridges of the clay-hills are weathered into most varied forms, some turret-shaped, others conical, and in many instances the peaks and ridges are capped by a natural brick material, burnt to a red colour by the combustion of the beds of lignite or tertiary coal which are scattered through this clay formation. The soil is unable to support vegetation, and this rugged and desolate country, which somewhat resembles the wilderness of Judæa, is called by the half-breed hunters "Les mauvaises Terres." Though the principal portion of this semi-desert occurs on the United States side of the boundary, a wedged-shaped area protrudes into British territory, measuring at its base on the boundary 7° of longitude, or about 320 miles, and tapering off north-

wards to a point near the Great Elbow of the Saskatchewan 125 north of the Line. In the central portion of this triangular district the plateau has on its north side a few sheltered ravines containing small groves of poplar, and in the country falling towards the north, being less broken, some good pasture is found. This locality, which is of very limited area, probably 36 square miles in all, was for a few years the winter residence of about 80 families of half-breed hunters, who, though originally belonging to the Red River Settlement, 25 days' journey to eastward, were forced by the migration of the buffalo to travel so far westerly in pursuit, that they were unable to return to Red River, and have consequently abandoned their old home, and have established their winter-quarters nearer the buffalo-country. This site, known as Woody Mountain, had been visited by many of the old half-breeds of Red River, and though it was suspected to be in British territory, it does not appear to have been visited by any travellers competent to determine its geographical position. It was consequently a matter of the greatest value and importance that the reconnaissance party of the British Commission during the summer season of 1873 were able to push so far to the westward as to discover the position of this oasis in the middle of the semi-desert, and but for the happy accident of meeting a party of Sioux Indians who said that they had just come from a hunters' encampment a long day's journey to the northward, this site would not have been discovered that season, for it lay 25 miles north of the boundary-line, concealed among the ravines on the reverse or north side of the plateau, of which the southern escarpment only had been explored, further progress northward having been arrested at the time by the equinoctial snow-storms, which left 18 inches of snow on the high ground, and completely filled up the valleys by drifts. The back track of the Sioux Indians was followed through the snow for 25 miles northward across the plateau, where the reflected glare of the snow was so great as to cause all the reconnaissance party to be more or less affected with snow-blindness. The rude and desolate huts of the half-breed hunters were found in some sheltered ravines, and, with one or two exceptions, all the families were absent in the direction of the Rocky Mountains for the autumn buffalo-hunt. A few hours' detention at this place, and the good fortune of a bright, sunny morning, sufficed to determine the latitude and longitude of this favourable spot, which was found to be 22 miles north of the boundary and 416 miles due west of the Red River. It was found from its position and natural advantages of wood, water, and good pasture, to be admirably suited for a dépôt site from which the Boundary Commission could complete the marking of the

boundary-line to the Rocky Mountains in another season. The autumn being well advanced—for it was now the 8th of October—by previous agreement surveying operations were suspended for the year, and a general retreat towards Red River was ordered; 408 miles of boundary having been continuously surveyed and marked by the Joint Commission during the four and a half months of the summer season, and at the same time a map was made by the British Commission of a belt of country throughout, for an average distance of 6 miles north of the boundary.

The latter part of the autumn season had not passed without one or two incidents worthy of record. The heat of the sun and the excessive drought during the summer had completely parched the prairie-grass, and the soil was fissured in all directions. Although the greatest vigilance was practised, the occurrence of prairie-fires seemed inevitable, and towards the end of August a pillar of smoke visible to the north, a great distance off, gave warning that before many days were past, the whole of the Great Plains would be swept by fire. The course of the fire was most capricious, and often turned by a ravine, or by a slight change in the wind, into a new course. The onward progress of the fire was noticed for many days by the gradually-increasing temperature of the air, and soon by the smell of the burning grass. The various parties of the Boundary Commission being scattered over 400 miles of longitude at the same time, experienced very varied fortune in their encounter with the fire. A surveying party working in one of the ravines 5 or 6 miles from their camp, found that the fire had swept round behind them and threatened their camp with destruction. They had just time to reach their camp, and to tear down their tents, and to plunge everything into an adjoining pool to save their camp-equipage, and much was partially destroyed. A commissariat wagon-train, drawn by oxen, was also overtaken by the fire, and though a burnt patch of ground was prepared, and the oxen released from the waggons and driven to it, the unfortunate animals were too much alarmed to remain quiet, but rushed about wildly in the flames and were badly singed about the legs. One of the men had the hair on his face burnt, and in the rush of wind accompanying the passage of the fire, his hat went away, adding fuel to the flames. At one of the astronomical camps one of the officers, seeing the onward progress of the fire, employed all the men in the camp to meet the fire and save as much grass as possible by burning a strip; this was so far successful that about 400 acres of grass were saved, which were of incalculable value to the transport-animals on the final retreat; but the fire that had been started with this object at last got beyond control, and swept back

upon their own camp and nearly destroyed it. On one occasion one of the labourers thoughtlessly struck a match on his boot in a patch of long grass, and in an instant the fire flew, and though the camp was saved, the effect of that fire was afterwards ascertained to have destroyed the grass for 150 miles of longitude, and then to have turned southwards, when it is probable its progress in that direction was not arrested till it reached the Missouri River. The result of all these prairie-fires, which raged in different localities between the middle of August and middle of September, was that the general appearance of the country was now changed from the universal yellow tint to a dismal black, and the whole surface of the plains was as bare of herbage as the sand on the sea-shore. The homeward march was consequently rendered doubly anxious by the want of fodder for the horses and oxen; but by diligent search patches of grass in marshy places were found, where the fire could not reach, and to such places mowers would be sent with light waggons to cut as much grass as they could find during the day's march, and bring it to the main body later on in the day, at the camping-ground.

From the experience of the previous year at Red River, the period of the autumnal equinox was looked to with some anxiety; and the equinoctial snow-storm of the autumn of 1873 was unusually severe. The operations of the Commission had at that time advanced so far westward into the plain as to be beyond the reach of fuel of any kind, and the line of travel as well as the camping-grounds were necessarily in a shelterless country. The great snow-storm commenced suddenly with little or no warning, on the 23rd of September; and the various working parties, as well as the commissariat trains that happened to be on the march at the time, made such shelter for themselves as circumstances would permit. By placing the waggons in a horse-shoe form, and stretching canvas-sheets on the interior side, shelter was afforded to the horses from the driving sleet, which now set in with great violence from the north-west. The light canvas-tents formed but a poor protection for the men, and, in the absence of fuel, there was no help for it but to huddle together and get under their blankets. The storm continued, with scarcely any intermediate lulls, for seven days, during which period it was impossible to get the horses to graze, for as soon as they were turned out they would all come back again to the shelter of the waggons. During these seven days of forced inactivity, the horses lost flesh sadly, and many were incapacitated from work for the remainder of the season. Although this storm, as we well knew, was the forerunner of some weeks of fine autumn

weather, it bequeathed to us a substantial legacy of 8 inches of snow, which caused great difficulty and discomfort in executing the concluding operations of the season; and though the snow in course of time disappeared on the lower levels, the higher ground was still covered with snow a fortnight after the storm. I heard afterwards that the half-breed hunters, who were in temporary camps hunting buffalo to the west of us, were also caught by the storm, and some of them were unable to find their way back to the camp, and were afterwards found frozen under the cover of some buffalo-hides, which they had stripped from the animals they had just killed. The melting snow fortunately filled up the low lying pools, and supplied water in places where it was greatly needed. The whole of the British Commission made good their retreat to Red River in independent detachments, as originally organised for the work of the season, the rearmost party arriving on the 31st of October; and three days previously the Red River was completely frozen over, having remained open for navigation for about six months. The sudden closing of the river, a fortnight earlier than usual, caused great inconvenience, and both steamers and small boats found themselves suddenly frozen in and compelled to pass the winter at places where they had made no preparation for winter-quarters, and where they were in great danger of being crushed by ice on the breaking-up of the winter. The horses and oxen of the Commission were housed in wintering stables, which were specially built half sunk in the ground. During the winter of 1873-4, the permanent staff of the Commission were fully occupied in revising astronomical calculations and preparing fair plans of the country surveyed during the previous summer and winter seasons, and special arrangements were made for the field operations of the ensuing season.

The operations of 1874 were arranged to be carried out in a similar manner to those of 1873; supply depôts were to be established at intervals of about 100 miles on the main line of communications, by which the working parties would procure supplies. As the work would, however, commence at a point 430 miles distant from Red River, and from there would gradually lengthen out in a direction generally due west, it was necessary to establish a new base from which the Commission would actually commence work, and in which they could fall back to winter, in case the work could not be completed to the Rocky Mountains during the summer of 1874. Woody Mountain was selected as the new base, and a contract was made with an enterprising American merchant of the Upper Missouri country, to deliver at Woody Mountain enough forage to meet the wants of the Commission for the first half of the working

season, while the same gentleman contracted to deliver at an intermediate point on the boundary, and nearer the Rocky Mountains, a further supply of forage to complete the requirements for the remainder of the season. It need only be added here that this contractor, with no previous knowledge of the country, except that it was occupied by Indians unfriendly to United States citizens, faithfully performed his contract with extraordinary risk to himself and his waggon-trains. In consequence of this element of uncertainty, the principal supplies of food and forage were freighted by our own Commission trains, direct from Red River; and for this purpose 125 waggons were employed by the British Commission, of which 100 were drawn by pairs of oxen, and 25 by pairs of horses. As it would have been inconvenient to have moved this large waggon-train in one body, an advanced party of 20 waggons, drawn by oxen, was despatched westward from Red River early in May, with orders to advance by easy stages in company with a road-making party, under Lieutenant Rowe, for the purpose of improving the road and building bridges over rivers and marshy plains. At the same time a reconnaissance party, under Mr. Crompton, with the light wooden carts of the country and native ponies, was directed to push forward to Woody Mountain, to commence the construction of dépôt buildings there, and to proceed 100 miles further to the westward to explore a site for a more advanced dépôt. These arrangements were carried out so efficiently that the main body of the Commission, starting a fortnight later with the bulk of the *personnel* and commissariat supplies, comprising 160 officers and men, and 70 waggons, advanced for the first 200 miles without a check to the first crossing of the Souris River. This river was not fordable, being in flood at the time, and flowing in a strong stream 55 yards wide. Three days were occupied in bridging the river, which was done by sinking at suitable intervals loaded cribs which supported the roadway. The materials for the bridge were collected at intervals, several miles distant, from the scant growth of timber on the river-bank. On the fourth day the whole train of heavy waggons crossed the temporary bridge without a casualty. Shortly afterwards a gloom was thrown over the whole of the Commission by the temporary disablement of Lieutenant Rowe, from fracture of the skull occasioned by a violent fall from his horse. As the precarious condition of this officer did not admit of his being moved, a hospital-camp was established on the spot, and, under Providence, Lieutenant Rowe's life was saved by the skill and unremitting devotion of Dr. Burgess, the Surgeon of the Expedition, and the companionship of Captain Ward, R.M., the Secretary, during six weeks of incessant watch-

ing and anxiety. The astronomical and surveying parties, under their respective officers, were detached from the main body at the foot of the Great Coteau, and proceeded by the boundary-line track to their several destinations, where they were to commence operations, while the heavy commissariat-train proceeded westward by an easier though more circuitous road to Woody Mountain. We arrived at this site on the 22nd of June, the oxen with loaded waggons having accomplished the journey of 450 miles in 32 days, inclusive of six days' halts or detention. The reconnaissance party, under Mr. Crompton, had arrived at the same place three weeks previously; and had already returned from a successful exploration of the country, for 100 miles to the westward; while all cause for anxiety respecting the delivery of the first instalment of forage from the distant settlements of South-West Montana was removed by the punctual arrival at Woody Mountain of 60 tons of oats on the 1st of June.

The method of freighting adopted by the Americans in the Western plains may be considered worthy of passing notice. Each vehicle is mounted on four broad-rimmed wheels of unusually broad gauge, and the body has nearly vertical sides, the whole height being 12 or 14 feet. Into this huge car 4 tons of grain are packed in bags; two of these waggons are linked closely together as in a railway-train, and to the foremost van are yoked nine pairs of oxen, the pair at the pole and the leading pair being thoroughly broken animals, while the intermediate pairs of oxen are more or less wild and untaught. One teamster manages this formidable charge. The waggon-train is made up of pairs of vans in the same fashion, and the whole makes its way slowly across the unbroken plain at the rate of about  $1\frac{1}{2}$  mile per hour. The drivers do not follow immediately behind each other, in order to avoid the ruts, which are cut to a depth of 6 or 8 inches in the dry ground, and the waggons frequently sink to the axletrees in soft soil. On coming to marshy places or to steep hills, the waggons are detached and taken one at a time over the bad places; an extra string of nine pairs of oxen, making eighteen pairs in all, being frequently employed to extricate a single waggon from a swamp-hole, or to take it up a steep hill. In this way oxen are found to work to the greatest advantage, as in a long string they pull at different times, and thus in turn obtain relief from the fatigue of continuous draught. The oxen are specially suited for marshy ground, as they do not sink in it, nor strain themselves by plunging when in difficulties, as a horse would do. The oxen are not shod in the first instance, as they travel better barefooted across the plains; but as soon as an animal becomes sorefooted, he is shod on one or more feet as may be found necessary. It requires special skill and

management to shoe an ox, as the animal has a great objection to having his feet touched. In the operation of shoeing, the ox has to be thrown on his back and firmly secured, and each foot requires two distinct shoes, in consequence of the split hoof. By carefully watching the oxen as they work, and by a liberal provision of spare animals in the first instance, who travel along with the train and give no trouble, the weak or tender-footed animals can always be relieved in good time, and, after a few days' quiet travel out of harness, they are generally fit for work again.

On the arrival of the heavy commissariat-trains of the British Commission at Woody Mountain on 22nd June, arrangements were made for pressing forward vigorously the surveying operations on the boundary, and every effort was made to keep the supplies of provisions if possible ahead of the work, while the reconnaissance operations were kept still further in advance. To avoid the broken and inhospitable country of the Bad Lands, through which the boundary parties had necessarily to work at the commencement of the season, the main route for transporting supplies was far to the north, and no passage could be found across the formidable gorge of White Mud River, nearer to the boundary than 16 miles to the north. Even to this point the astronomical and surveying parties had great difficulty in making their way in consequence of the intervening country being a rugged mass of ravines, ridges, and conical hills. On the plateau of White Mud River early in July swarms of locusts were found. The air was also full of them, and in looking towards the sun the air had the appearance of being filled with snow-flakes. The locusts in due time advanced into the Red River Valley, and destroyed the greater part of the crops as they had done during the previous summer. At this time the services of the half-breed scouts were found invaluable in their capacity of express riders, conveying orders between the different camps of the British parties scattered over 60 miles of boundary. A selected number of sound and powerful oxen advanced steadily to the westward with supplies at the rate of 16 miles per diem, while the immediate wants of the working parties were met in the first instance by a commissariat horse-train which was able to advance more speedily, so that supplies were ready for issue on 7th July on the boundary-line, at a newly established dépôt 150 miles beyond Woody Mountain, a fortnight after the first arrival of the expedition at the latter place.

The boundary-line, at a point 500 miles from Red River, having now emerged from the broken country, entered upon an arid plain of sand with some light soil intermixed, scarcely able to nourish a light sod, but a cactus-plant flourished in

great abundance. The buffalo were met with here in great herds, and on one occasion were noticed to be coming up from the south at a rapid pace. The waggon-train, which was on the march at the time and extended in single file over a long line, was hurriedly closed up and halted in preparation for the buffalo onslaught. The terrified animals came rushing on at a furious gallop, with their heads low down and enveloped in a cloud of dust, so that they could see nothing in front of them. The scouts in attendance on the waggon-train fearlessly rode at them, and fired at them with their breech-loading carbines, which had the effect of making the herd open out so that they passed on both sides of the waggon-train. It was then discovered that the herd were being pursued by Sioux Indians, who suddenly appeared and vanished again in the cloud of dust. The wounded animals dropped out of the herd, and became an easy prey to the rifles of the waggon teamsters. For about 100 miles of longitude, the plain was swarming with countless herds of buffalo, and, like an invasion of locusts, they swept everything before them. The scant vegetation was everywhere nibbled close, so that our own horses and oxen fared very badly. The few pools of water available for camping purposes were generally taken possession of by buffalo, and frequently one had the mortification of seeing a herd of buffalo charge into the only pond of water available for camp purposes, so that the water was spoiled for drinking, and even the horses could not be induced to drink it. However, some fresh-water lakes surrounded by an abundance of fine hay-grass were found on the boundary-line in the heart of the buffalo country ; and on this remote spot were encamped, during the months of June and July, 150 families of half-caste hunters, cut off entirely from the civilised world, and depending for food on buffalo-meat. They were assembled and organised as one community for mutual protection. Their home-made carts were arranged in a circular form, and packed closely together, forming an enclosure 150 yards in diameter, into which their ponies were driven at night and guarded. Around and outside the circle of carts, the skin-covered tents or wigwams were pitched, where each family had its home, and lived separately. Great order and regularity prevailed in the camp, principally due to the influence of a French priest who lived with them, and seemed to be their chief adviser in temporal as well as spiritual matters. Business was transacted by a council who met daily, and decided where they should hunt. On the hunting-days, the women and children driving the pony-carts would follow in rear of the hunters to carry home the meat. Each hunter would probably kill six or eight animals early in the day, and for the remainder of the day his whole

family would be employed cutting off the meat, the best pieces only being taken, the hide and forequarters being left. For many miles the air was soon poisoned, and in every direction could be seen evidence of the reckless slaughter and wanton waste of the hunters. The half-breeds are in constant collision with the Indians, and no quarter is either given or received.

The 50 miles of arid cactus-plain, already alluded to, is bounded on the west by the remarkable gorge of the Milk River, and for 12 miles the boundary-line is engulfed in the main valley and its tributary ravines. This gorge was explored for 40 miles of its course before a crossing-place for waggons could be found, and the only favourable passage proved to be 10 miles south of the line. The country on both sides of the main valley is much broken with tributary ravines and gorges, the banks of which are in most places nearly perpendicular, and rising 300 feet above the river-level. The river itself is very insignificant, and at the fording-place, where the current was running rapidly on the 10th July, the stream had completely disappeared in the sand a fortnight later, and the water was found in pools only, and in most places brackish. In the arid plateau, stretching for 25 miles westward beyond the Milk River, some sage-bushes occur; both rattlesnakes and the large prairie-fowl, or wild turkeys, were found in this district, which is of similar character to the great plain of the Columbia, west of the Rocky Mountains.

We were now approaching the three Buttes or Sweet Grass Hills, the most prominent and important feature of the western plains. The first view of the Buttes was obtained when standing on the high ground overlooking the sandy cactus-plain. From this point of view the nearest Butte is 100 miles distant to the west, and its conical peaks, which stand out mistily against the sky-line when viewed in the early morning, are quite lost in the haze of the afternoon sun. Thus, to a traveller approaching the three Buttes from the eastward, they seem to recede during the day's travel, and though invisible at sundown, at sunrise the next morning they appear to have advanced close to the camp. At the foot of these hills their influence is very noticeable in the growth of more luxuriant herbage on the soil, by reason of the rainfall which occurred daily among the hills, while no rain fell on the surrounding plain. On passing around the northern slope of the eastern butte, the summit of which is 6 miles south of the Line, the plain was much broken and intersected by valleys and ridges, and for 25 miles the reconnaissance party had some difficulty in finding a practicable route to the westward for the heavy wagon-train. After crossing much undulating ground, an excellent site for a principal dépôt was found a little north of the boundary-line, on a small stream running southwards from the wes-

tern butte, and the indomitable oxen arrived here with full supplies, in charge of the commissary, Mr. Herchmer, and his indefatigable waggon-master, Mr. O'Donnell, on the 24th July, on which date the second astronomical party under Lieutenant Galway, marching independently, arrived at the same point to commence operations. The British Commission had thus, in seventeen days, made a further stride of 108 miles to the westward. A few days' detention at this dépôt site afforded opportunities for an examination being made of the three Buttes, and Mr. Dawson, the geologist, reported that they are of igneous origin. They form a little mountain region of themselves, the highest peaks being 6800 feet above the sea, and from the heart of the Buttes precipitous valleys open out, well wooded, and in which there is an abundance of springs, which issue for some distance out on the plain and are there rapidly absorbed. In the recesses of the mountain region, horned sheep were found, and the buffalo in vast numbers are attracted to the luxuriant pasture-grounds that abound on the hill-sides. The deadly combats that have occurred between the Blackfoot and Crow Indians, when meeting in this region in pursuit of the buffalo, have in some degree made it a neutral ground, but a recent battle must have been fought, as the bodies of twenty Crow Indians were found on the plain a few miles from the dépôt camp. They were all scalped, and in consequence of the intense dryness of the atmosphere, the bodies were completely sun-dried and well preserved. From the hill-sides of the western butte, the Rocky Mountains, 115 miles distant, are in full view, and the mountain-peaks, in a rugged and snowy outline, stand out in full relief against the western sky-line. Anyone ascending the northern slopes of the western butte comes to the boundary-line at the same spot where the first view is obtained of the Rocky Mountain peaks. The intermediate country consists of undulating and gravelly plain, over which one passes imperceptibly from the basin of the Missouri to the Saskatchewan Waters at St. Mary's River. This river rises in the mountains, and flows northward boisterously in a channel full of boulders and shingle. No sight could be more welcome than the clear and sparkling waters from the mountains, after the stagnant pools and muddy rivers of the Great Plains. Many granite boulders were found on the plateau near St. Mary's River. The bed rock, from which these blocks must have travelled, is 700 miles distant. Some bituminous coal was found exposed in the river-banks. On crossing St. Mary's River the boundary-line enters the fertile belt which extends for 25 miles to the base of the Rocky Mountains. A great change for the better is now observable in the soil, which is very undulating and even hilly before arriving at the actual base of the moun-

tains. A thick vegetable soil supports a luxuriant growth of grass, and groves of poplar are found, the growth of which is checked by the fires which occasionally sweep through the country. Although we are now 4000 feet above the sea at the foot of the mountains, the same plants that were noticeable in the Red River Valley reappear here, having been wanting in the intermediate country, while birch and coniferous trees are found in sheltered localities. The evidence points to the conclusion that the climate is much milder here than in the Red River Valley, and the actual experience of the settlers in Montana at the foot of the mountains, 300 miles further south, is that this fertile strip of country is well suited for the growth of cereals, and cattle can winter out. The mountain-streams abound in fish, and it was no uncommon thing for a man, during an afternoon's fishing with a rod and line and grasshopper-bait, to bring home a sackful of 3 lb. trout by the evening. The boundary-line passes through 20 miles of out-lying mountainous country, which can be avoided by a detour of a few miles to the north, to the foot of the great mountain barrier. The mountain ranges rise at once into precipitous peaks 4500 feet above the plain, and the mountain masses retreat north-westerly in successive ranges. The horizontal strata of the plains are suddenly broken by the crumpled rocks of the mountains, elevated by a great convulsion of nature. The limestone beds on the peaks and mountain ridges, are weathered into the most bold and rugged outline, while underneath are the sandstone beds of variegated colours.

In a cleft lying due south, Waterton or Chief Mountain Lake is enclosed, and by rafting on this lake access is obtained to the boundary-line in the heart of the mountains. The lake opens out northwards to the plain, and at its extremity is the western limit to which wheeled vehicles can be taken. A remarkable collection of mounds on the plains at the outlet of the lake was found by Mr. Dawson to be composed of moraine-matter, deposited by a great glacier, which must at one time have pushed northward down the valley of the lake and debouched on the plain.

For the concluding operation of the Commission in the mountain ravines, a train of pack-animals was organised, and the old trail of the Kootenay Indians was followed through the mountains over the dividing ridge at an altitude of 6700 feet above the sea; thence descending on the western side the surveying operations were continued into British Columbia and finally connected with the terminal point erected by the former Boundary Commission on the summit of the Rocky Mountains in 1861, being the eastern limit to which the boundary opera-

tions from the Pacific side had been carried at that time. The old trail was completely blocked up by fallen timber, and had to be cut out afresh; the original axemen's marks were almost grown over, and had become covered with thirteen rings during that number of years that had elapsed.

The old boundary-cairn was found to be in perfect preservation, the remains of an old flagstaff, around which the stones were built, being still in position and standing out conspicuously above the top. There was no appearance of any Indian or white man having visited the spot since the boundary parties were there, 13 years ago. The beavers had, however, been very busy during this period; for at one place on the old trail they had formed a lake by constructing a dam across a narrow part of the valley, which caused the water coming from the mountains to be kept back till they overflowed the obstruction. From the mountain-summit the view embraces a sea of peaks and ridges of the boldest outline, and between these knife-edged ridges occur amphitheatres of horse-shoe form with precipitous sides 3000 to 4000 feet deep, enclosing at their bottom a placid lake, in which the waters, from their great depth, appear of deep blue colour. A great difference is observable in the physical appearance of the country on the east and west of the dividing range of mountains. To the east may be seen glimpses of the treeless plain, which extends for 800 miles to the eastward, and to the west of the mountain-range is a confused mass of rugged peaks and ridges and pine-clad valleys, which extend in almost an unbroken series for 400 miles to the Pacific coast.

During the 10 weeks of magnificent summer weather, the Joint Commission had completed the surveying operations comprising 350 miles of boundary, to the terminal point on the summit of the Rocky Mountains, and the British Commission commenced their retreat eastward from the mountains on 29th August. Official information had been received from the Canadian Government at Ottawa that the Indians intended to attack us on the march homewards. They were known to be in great force in the neighbourhood—the Blackfoot tribe alone numbering 6000 warriors—and their scouts were seen to be watching our movements. The fact was rather ominous that none of their chiefs had visited our camp, so nothing was known of their intentions or of the light in which they regarded the proceedings of the Commission. We commenced our retreat at a much earlier date probably than they had expected, and as we were then collected into sufficiently large parties to protect ourselves no molestation was offered. The camp was always formed by the waggons being arranged in a circle, and into the enclosure so formed the horses were driven at night.

The tents were pitched around and outside the waggons, while sentries patrolled the outskirts of the camp.

The depôts were necessarily kept in charge of a few men only, and the commissariat-trains travelling from point to point with no escort would have been an easy prey to the attacks of hostile Indians, and some anxiety for the safety of the smaller parties was occasioned by large bands of Indians, numbering 200 and 300, coming at different times to the supply depôts and demanding food. All the Indians of the plains were well mounted and armed with breech-loading rifles, which they procure from the Missouri River traders. Although they paid their visits with friendly assurances, it was evident, from their being in great force and well-armed, that they were prepared for any emergencies. It was owing to the firmness and tact of the members of the Commission, and the discipline infused by the small detachment of Royal Engineers, that the most friendly relations with the Indians were maintained.

The transport-animals had greatly recruited during the fortnight's detention at the mountains, where the pasture was most luxuriant, and they were in excellent condition for the long march to the east. By the 19th September the whole of the British Commission were collected at Woody Mountain, having accomplished 410 miles of the march homewards in 22 days. From this point to Red River hay had been made and stacked at 20 miles' intervals, in anticipation of the equinoctial snow-storms and the destruction of the natural grass by prairie-fires. The autumn season of 1874 was, fortunately, most favourable, and the homeward march to Red River was accomplished without casualty, 861 miles in 43 days. The trains of oxen had been despatched from the Rocky Mountains three weeks earlier, and they reached Red River a week before the horse-trains and the main body of the Commission. Special mention must be made of the extraordinary power and endurance of the oxen. They commenced their march from Moorhead in Minnesota early in May, and from that time till their return to Red River on 5th October, they marched 2400 miles with loaded waggons out and back, at an average rate of travel of 16 miles a day. During the whole of this period they had no other food except such pasture as the country afforded on the march. The horses, on the other hand, received a daily ration of 10 lbs. of oats per diem, and were able to average 22 miles a day with loaded waggons, while on emergencies they were able to make much longer marches, when the want of water or some special occasion required it. The general arrangements of the season just described necessitated the supplies being transported by our transport-train over a line lengthening out at last to

900 miles, and the establishment of supply-depôts at seven intermediate points, averaging 120 miles apart. Two-thirds of the *personnel* of the expedition were employed in administering to the wants of the remaining third, who were actually employed in the operations in front.

The 900 miles of boundary-line between the Lake of the Woods and the Rocky Mountains may be divided geographically into three distinct steppes or prairie-levels. The first extends from the Lake of the Woods to the Pembina Mountains, and has an average altitude of 800 feet above the sea, with a width in longitude of about 130 miles. It consists principally of rich fertile land, with a considerable amount of timber in the Lake of the Woods district. The second prairie-steppe extends from Pembina Mountain to the Great Coteau of the Missouri, 250 miles of longitude, and has an average altitude of 1600 feet above the sea, with good pasture, and a small supply of wood in the valleys. The third prairie-steppe extends from the Great Coteau to the foot of the Rocky Mountains, 460 miles in longitude, and has an average altitude of 3000 feet above the sea. Much of this district is semi-desert, though pasture, in more or less quantity, is found everywhere. These three prairie-steppes have a marked dividing line at the Great Coteau and Pembina Mountain, but they have also a regular ascent to the westward of about  $4\frac{1}{2}$  feet in a mile, while, looking northward from the boundary, there is also a gradual descent to the Arctic Ocean. The lowest point along the whole boundary now described is at Red River, 750 feet above the sea. The Lake of the Woods in the east is 1000 feet, and Waterton Lake, in the Rocky Mountains, 4200 feet above the sea.

The whole boundary from the Lake of the Woods to the Rocky Mountains is now marked by stone cairns or earthen mounds at 3-mile intervals across the great plains, and by iron pillars at 1-mile intervals, for 135 miles throughout the southern boundary of Manitoba. As this prairie is destined before many years have passed to be the great granary of the Dominion, and from its enormous agricultural capabilities much of its produce will, in course time, come to Great Britain, it may be permitted to add a few concluding remarks concerning the present condition of Manitoba. The soil of Manitoba is mostly prairie covered with grass, and is a deep alluvial deposit of unsurpassed richness. It produces bountiful crops of cereals, grasses, roots, and vegetables. The soil is so inexhaustible, that in some places the old settlers have raised a crop of wheat off the same plot of ground for forty successive years. The wild grasses of the country are particularly favourable for stock-raising of all

sorts, as the grass of the prairie is very nutritious, and the supply inexhaustible. It is more profitable to cut the grass for the winter season and to shelter the stock, than to allow them to run. The grass can be cut by machines, and roughly stacked around the stock-yard. Wool-growing would be most profitable, as it is easily exported, and would command the same price where land is dear, and where hay has to be raised on cultivated farms. Moreover, the winter food of sheep and oxen—such as turnips and carrots—can be raised with great advantage on prairie soil.

The climate of Manitoba is one of great extremes. The situation of Manitoba is peculiar, being in the middle of the continent, nearly equidistant between the Pole and the Equator, and the Atlantic and Pacific Oceans. The snow goes away and ploughing begins at the end of April. Crops are often harvested in ninety days from the time of sowing. This is due to the long sunny days of summer, which bring vegetation of all sorts to maturity. Snow on the prairies does not fall to a greater average depth than 18 inches, and horses can graze out all winter, scraping the snow. Cattle in the spring are quite fat after the winter's feeding.

The drawbacks to the country are:—

1st. The want of markets.  
2nd. Ravages of the grasshoppers.  
3rd. Occasional summer frosts. The first great drawback is already in course of removal, as it is expected that in the course of a few months railway communication will be completed northwards from Minnesota to Winnipeg, the capital of Manitoba. This will bring the new province within fifteen days of Liverpool, by a route available all the year round.

Already the Canadian Pacific Railroad is in active progress, the work being carried on from Fort Garry eastward, while some sections of the railroad north of Lake Superior are staked out on the ground. Thus the Red River settlers will soon have two outlets to the ocean for their produce, and the competitions between these two railroads will doubtless keep the railway rates and fares at a minimum. In the mean time the Government route from Lake Superior to Fort Garry is very greatly improved every year, and steamers are already plying on many portions of the route where the water-communication is continuous. By this route emigrants are conveyed to the new Province at a nominal charge.

The plague of locusts is undoubtedly a most serious drawback. The ravages of this insect have been widespread over the Colony for the past four years. We read, however, that there was no invasion of this pest in the colony for 36

years—from 1820 to 1857—and the settlers are not disheartened, for I have recent information that a greatly-increased area of land is to be put under cultivation this spring.

The summer frosts occur rarely, and then confine their injuries to fruit-trees and delicate plants; and sometimes the wheat-crops suffer. The oat-crop is rarely injured, and the root-crops are certain to succeed.

The wave of emigration has set in steadily during the past four years. The Mennonites, from Odessa, are pouring into the Colony, and have already established themselves on the Prairie along the boundary. They found water readily by digging from 18 to 25 feet, and the scarcity of wood is thought nothing of, as they are accustomed to use bundles of straw for fuel. A colony of Icelanders has also settled in the Province, and are well satisfied with their new home.

The settlements to the west are increasing rapidly along the projected line of railroad. A steamer has recently ascended the Saskatchewan River to Fort Edmonton; the line of telegraph will be completed to that point in the course of a few months. The surveying parties from opposite sides are working towards each other in the Rocky Mountains for the railroad-route in that section. The Government have recently paved the way for settlers by appointing magistrates to different points throughout the new territory to the Rocky Mountains; and the civil authority is maintained by a force of 300 mounted police, under Captain French, of the Royal Artillery, who has already established the most friendly relations with the Indians throughout the country. The Canadian Pacific Railroad will pass through a fertile belt of country, the greater part of which will, in course of time, be occupied by an industrious though scattered population. The snowfall along the line of route is less than at Red River, and much less than in the eastern parts of Canada; and one great disadvantage to this part of the country, namely, the want of wood for fuel, will be met by developing the great coal-fields of the Saskatchewan, where bituminous coal abounds.

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## APPENDIX.

In order to define the boundary-line or 49th parallel of latitude on the ground, successive points along the boundary were determined by astronomical observations on that parallel of latitude, and the intervening spaces of boundary would naturally be defined by east and west lines, with the proper allowance made for the curve of the parallel to the north, connecting the successive astronomical stations. It was found, however, that at all these stations there was more or less local attraction, due to irregularities in the

density and figure of the earth, deflecting the plumb-line from a truly vertical direction, and the successive astronomical stations, although accurately determined to be in latitude  $49^{\circ}$  N., were found to be on different parallels of latitude, when connected by actual surveyed lines. Discrepancies of this kind were always found to occur, so that the parallel passing through one station would not, if traced with the proper allowance for curvature, be identical with the parallel passing through the next station, and so on. It thus became necessary to decide whether the points determined astronomically to be in lat.  $49^{\circ}$  N. should be simply joined, or whether a mean line parallel to the Equator should be adopted. The opinion of the Astronomer Royal was taken on this point, which was to the effect that there should be no departure in the smallest degree from the points determined by the actual use of astronomical instruments. It was thereupon agreed between the British and United States Commissioners that the astronomical determinations of each station should be adopted, and the intervening boundary-marks between the stations should be set up on lines connecting the adjacent astronomical stations having the same curvature as the 49th parallel of latitude, but not necessarily parallel to the Equator. Thus the work of marking the actual boundary-line proceeded *pari passu* with the establishment of the astronomical stations. The method of determining the latitude which was agreed upon by the Joint Commission, was by observing the differences of the zenith distances of north and south stars with the zenith telescope. The local time for the reduction of the zenith telescope observations was obtained by the use of the sextant, by the transits of zenith stars observed with the zenith telescope, or by transits observed with the portable transit. These instruments were mounted on massive tripod stands specially made by Mr. Simms for the Expedition. The stands were packed quite flat when they were taken to pieces, and were transported very easily.

The method of working generally practised by the astronomical parties was as follows:—On approaching the site selected for an astronomical station, usually at about 3 P.M., though sometimes much later, the first step was to select, for the observatory tent, an elevated spot from which an uninterrupted sight-line could be obtained to a distance of about three-fourths of a mile, either due north or due south. The camp was then pitched at a short distance off, so that neither the north or south, nor the east or west lines from the observatory tent came within 100 yards of it.

The true time of the last astronomical station having been brought forward on a pocket mean-time chronometer, or sometimes on an ordinary watch, the sidereal chronometer was started by it, allowance being made for the difference of longitude obtained from the reconnaissance sketches; and observations for time on the sun in the west were taken with a sextant for combination with equal altitudes the next morning. The zenith telescope was next mounted and adjusted, the direction of the meridian being obtained by observation of the transit, according to the time by account, of a circumpolar star as soon after sunset as practicable.

When darkness had set in, the latitude observations were commenced, a correction to the approximate time being soon obtained by taking transits of two zenith stars, and were continued throughout the night until dawn began to appear, the meridian being also altered if necessary during the course of the observations. The next morning equal altitudes were taken on the sextant corresponding to those obtained the previous evening, and the true chronometer error during the night being now known, the computers could set to work at once to reduce the latitude observations. A first value of the latitude of the zenith telescope was obtained before the afternoon, and a spot was selected the proper distance north or south of it, so as to be nearly on the 49th parallel, and, if possible, on the meridian of the instrument, from which

point the sight-line, tangent to the parallel, should be commenced ; a view of nearly a mile due east or west, and also north or south being essential. The 7-in. theodolite was mounted here, and as soon as Polaris could be found in the evening, an approximate meridian was established and a mark set up. The theodolite was then replaced by the portable transit-instrument which was directed on this mark. All this could generally be done without interfering with the zenith telescope observations for latitude, which it was important to complete as soon as possible. These were continued on the second night without interruption ; but in the early part of the evening, and from time to time during the night, opportunities would occur for observing the transits of stars across the meridian of the transit instrument. The azimuth of this meridian was thus obtained within one or two seconds, or less, of arc. On the second day the computations were continued, and preparations were made for commencing the sight-line to connect with the station to the west. For this purpose the 7-in. theodolite was placed over the spot where the portable transit had stood, and an angle of  $90^{\circ}$  was turned off to the west, giving a line approximately tangent to the parallel. A mark was set up on this line at a distance of about three-quarters of a mile, or more, if possible. The angle between this mark and that in the north was then read off on different parts of the arc, and in reversed positions of the face of the instrument, and the mean of these angular readings, combined with the azimuth of the meridian, gave that of the sight-line, which was generally a few seconds north or south of west. The sight-line was now ready for prolonging westward ; its deviation being left uncorrected, but being taken into account in computing the offsets to the parallel. On the third night the zenith telescope observations were continued and completed, subsidiary observations for correcting the constants of the instrument being taken if required.

On the third and fourth days the computations were finished and checked, and as soon as the final value of the latitude of the zenith telescope was obtained, the required measurement to the parallel was made, and the mound marking the station erected. During the fourth and fifth nights additional observations for azimuth were taken, as well as any additional ones required for the latitude. The sidereal time was obtained from day to day by equal altitudes of the sun, and also by observations of the transits of zenith stars at night.

The time of completing a station, which, according to the above description, would be four days and five nights, was actually always more than this. Sometimes the first night could not be used for latitude observations, owing to the party having arrived too late at the station to make the necessary preparations ; and one night out of three was generally cloudy or unfavourable to observation owing to thunderstorms or gales of wind. The average time necessary to complete one station was seven days during the summer months. In order to provide against delays from cloudy weather, it was always the object of the officer in charge of the astronomical work to obtain, as early as possible, an approximate value of the latitude, within 20 or 30 feet, and an approximately true meridian ; having obtained these, the tangent-line could be commenced, and, in the event of cloudy weather setting in, could be prolonged for 9 or 10 miles, while, if the sky remained clear, the astronomical observations were carried on to completion.

When the astronomical station was completed, and the monument marking the parallel erected, the camp was shifted to some spot where water was to be had, about half-way to the next astronomical station. During the march, the line was run with the 7-in. transit theodolite from the initial point, or from wherever it had been already taken to, while the party was encamped at the station. From the new camping-ground the line was continued as far as the next astronomical station, if possible ; but if it was not within working distance, the camp was again shifted to an intermediate point. The pro-

longing of the tangent line was done with the 7-in. transit theodolite, each point in advance being determined by two observations with different faces of the instrument, to eliminate the residual collimation and errors of level adjustment. The time occupied in running an average distance of 20 miles of line was about four days, to which three more must be added for laying down the offsets from the tangent to the parallel, where the monuments or mounds were to be erected.

Azimuth observations were taken at or near the end of the line to verify its direction, and any small error which had accumulated in the process of laying it down was distributed over its whole length.

When this work was finished, the party started for their next station, about 80 miles further west, on arriving at which the same process was recommenced.

Working parties under an officer were employed to construct the permanent boundary marks, at the points indicated by the surveyors at about 3-mile intervals. These marks were either earthen mounds, substantially built, 7 feet high and 14 feet diameter, surrounded by a circular ditch, or were composed of boulder stones, whenever they could be procured in the neighbourhood, compactly arranged and forming a conical cairn. Throughout the province of Manitoba, for 135 miles, the boundary was marked by iron pillars set up at mile intervals.

In connection with the marking of the actual boundary-line, an instrumental survey was made, by the Joint-Commission, of the country 6 miles on both sides of the line, and an exact map prepared of the rivers and well-marked features of the ground. The system pursued by the British parties was to traverse, with the 5-in. theodolite and chain, the watercourses and ridges from their intersection with the boundary up to the 6-mile limit. The traverse line was then carried due east or west, as the case might be, and check lines chained at intervals of 6 or 9 miles down to the 49th parallel. The topographers, following the chained lines as a base, were able to sketch the features occurring in the intervals not actually surveyed. The sketch-sheets were plotted on the scale of 4 inches to one mile, and each sheet represented a block of 3 miles square. All these sheets fitted together like the squares of a chess-board, and were reduced afterwards to the scale of 1 inch to a mile.

The observations for latitude and longitude, taken on the reconnaissance for fixing the approximate position of the astronomical stations, and for making a sketch-map of the country, were taken with an 8-inch sextant, the sun and the stars both being used. The sextants made by Messrs. Troughton and Simms for this expedition were perfect instruments of their class. A set of ten observations on a north and on a south object could always be depended on for determining the latitude within 100 yards. In cases where combined observations of objects on both sides of the zenith could not be obtained, the instrumental error of the sextant which had been investigated was applied. On the march the instruments were carried in a light spring waggon, and were always at hand for taking observations on the sun during the day, at the hours best suited for finding the time and latitude. For the longitudes, the local times calculated from five observations on an east and west star, moving rapidly in altitude, were compared with that brought forward on four mean-time pocket chronometers, whose travelling rates were ascertained by taking them back to the starting-point, and observing for time there after each reconnaissance; the resulting differences of longitude so obtained over distances of 100 miles and upwards, served as a check on the survey. The reconnaissance sketches were based upon the successive points fixed astronomically in latitude and longitude, and the natural features along the line of travel were sketched in with the aid of a prismatic compass.

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